

ELECTRONIC WASTE: CONCERNS OF LIGHTING LAMPS IN JHARKHAND

UMESH KUMAR¹ & D N SINGH²

¹Electronics & Communication Engineering, Department of Science & Technology, Jharkhand, GWP Ranchi,
Tharpakhana, Ranchi, Jharkhand, India

²Joint Secretary, Department of Science & Technology, Bihar, SBTE, Patna, Bihar, India

ABSTRACT

Technological advancement, proven ways of shift from conventional products to advanced products resulting in increase in efficiency, improved efficacy, saving power, applications results in accommodation to make shift for other applications. Increased life span, lessening of dependence on voltage and temperature fluctuation results in end of life i.e. disposal situations will lead to a better scenario where valuable materials are less used and are less responsible for degradation of environment and leave space for less hazards for humans and living beings. Shift from Incandescent lamp which has light conversion of 1-3 % to conventional fluorescent tube and CFL for conversion ratio of 18 -20 % which unfortunately has mercury contents now reduced from 15 mg to 5 mg and thereafter shifting to LED lamps for even better power to light conversion will ease the situation of power deficiency. It is well known that a unit saved is equivalent to 2.5 units generated so more and more emphasis for energy saving has to be targeted. It is well known fact that lighting consumes 20 % power. Thus reduction in 20 % power for lighting to further reduced level will enable other useful power driven sectors to have more power for purposeful use. Increase in life span which is of the tune of 1 incandescent lamp equivalent to 2.5 to 3 CFL and further equal to 22 lamps marks the importance in reduction in waste generation as reduced use of lamps will result in lesser wastes demanding reduced efforts for technological disposal for environment hazardous effects. Reduction of cost and further reduction of use of hazardous material for manufacturing and creation of awareness will enable further power saving and reduction in electronic wastes. Major concern is cost and awareness which still remains a factor which is impeding the shift to more efficacy. Development of proper EPR and network for collection of disposable lamps for recycling / reuse is another area of concern which will enable extraction of valuable materials from waste at one end and advanced technological disposal will result in reduction of hazardness in environment.

KEYWORDS: Incandescent, CFL, LED, Luminance, E Waste, End-of -Life, Mercury, Hazards

INTRODUCTION

With growth of civilization and knowhow of mankind and existence of day and night in the universe can be seen as periods of working and rest. This division itself is based on the availability of light. The natural source of light in universe is sun. The graphical positioning of earth decides the proportion of duration of availability of light i.e. day. With growth of Civilization, technology advancement also took place and man tendency to quest for many things required him to elongate the working period which in turn lead to various inventions including the elongation of working environment requiring standby provision of lighting. Primarily for many years fire and small prepositions of fire solved the situation besides growth of oil and gas lamp arrangements for lighting. By replacing the oil and gas lamps since 1900 incandescent lamps were developed as primary choice for residential lighting. With minor advancements in construction

basically use of electric current for heating small coils as filament producing light have been key technology of light production. This arrangement is known as Incandescent lamp.

The decade of sixties and seventies saw an extreme shortage of electrical power. Fact that incandescent lamp convert only 1-3 percent of electricity consumed into usable light lead to stress for development of efficient means of consumption of electricity in lighting. The consumption of energy for domestic uses amounts to around 30 – 40 % of power generated where as the power consumed for lighting in developed countries is around 20 % and slightly higher in developing nations. The excessive consumption and scope of saving power for industrial uses for prosperity of nations massive efforts were put in and this lead to development of conventional Florescent Tube light (FTL), Compact Florescent light (CFL) and Light Emitting Diode (LED) light arrangements. The latter developments at one end save considerable amount of energy and have considerable life also compared at positive nodes but have hazardous substances like Mercury, Phosphorous and semi conductors adversely affecting environment which have to be addressed and dealt with. This saved power to the extent of 60 to 80 %. One unit of power saved during consumption is equal to 2.5 units of power generated. Mostly in developing and underdeveloped nations still use of less efficient incandescent lamps are in practice for economical and awareness reasons.

The use of technology driven products which largely depends on electrical electronic equipment (EEE) development which has different stages from inception of use, reuse, recycling, modification, preservation of raw materials, disposal and other associated problems and precautions. The disposal of EEE comes after the end of life of any product when all means of its utility has exhausted. These disposable items are popularly known as electronic waste (e waste). The e waste constitutes around 1 – 3 % of total waste being generated. The reduction of e waste generation is the best solution of tackling of e waste. The reduction, ways and means of extension of life of products, awareness about technology and options available are the major areas where articulations and detailed studies are required.

The present paper and study mainly focus on the issues of analyzing the different technologies applications, details of manufacturing, minimization of health hazards, awareness, environmental concerns, sustainable development vis-a-vis electronic waste considerations etc for the national and regional level with reference to lighting products.

LIGHTING SECTOR ANALYSIS IN INDIA

In India power consumption in lighting is around 18 % of total power. Basic lighting arrangements in India or worldwide can be divided in these segments , namely Incandescent lamps , florescent tubes and semiconductor based light emitting diode lamps. Annual growth of lighting industry is on an average about 12% per annum since inception till date with varied participation of individual segments. Growth rate of convention Incandescent lamp (GLS) is more than 20% mainly due to economical factors. Growth rate of conventional fluorescent lamp and High Intensity Discharge (HID) lamps which include mercury vapor, metal halide, and high-pressure sodium lamps, potential users of Mercury have registered growth rates of 10 % and 24 % respectively in 2006 [1].

The penetration of energy saving relatively cost effective CFL has touched growth rate of even 50 % in certain years say 2006 By 2006 it grew to more than 100 million pieces and unabated it is gaining the growth. In general one can say that Mercury users segment of lights mainly are Fluorescent Tube Lamps (FTL), High Intensity Discharge (HID) Lamps, Neon Lamps and Compact Fluorescent Lamps (CFLs).

Growth rate of LED lamps is negligible in domestic sector mainly because of its cost. The main users are the commercial establishments. The increase in manufacturing of lamps can be seen in table 1. [2]

Table 1: Showing Manufacturing of Various Lamps

Year	Incandescent Lamp in m	Florescent Lamps in m	Special Lamps in m	CFL in m
2001-02	542	174	6	20
2002-03	662	176	7	35
2003-04	724	179	8	45
2004-05	710	180	10	67
2005-06	757	186	14	100
2006-07	789	190	17	140
2007-08	734	186	21	199
2008-09	766	179	18	255
2009-10	797	175	16	304
2010-11	755	180	18	340
2011-12	725	165	17	408
2012-13	766	167	21	657
2013-14	735	171	20	792

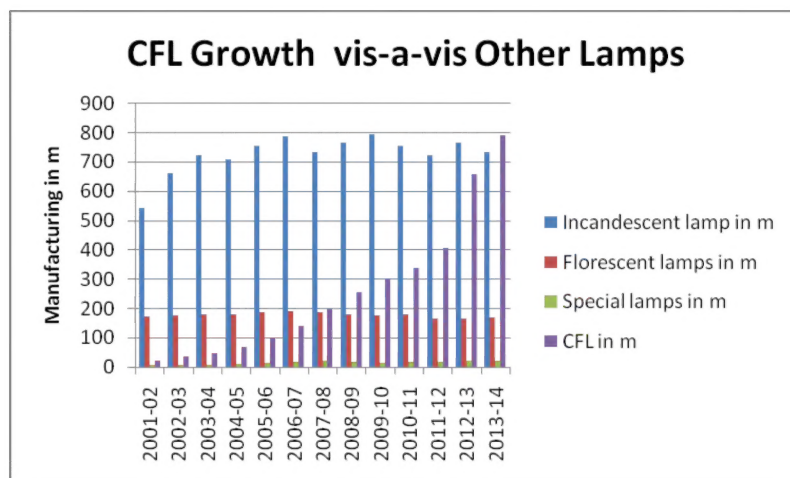


Figure 1: Showing Graphical Representation of Manufacturing of Lamps in India

In India use of lighting is divided in commercial and domestic sectors. The sharing of use as per [2] report has been placed and its graphical representation is shown in table 2 and figure 2.

Table 2: Showing Percentage Share in Use of Lamps

Types	Overall	Commercial	Domestic
Incandescent lamps	61	5	60
Florescent lamps	14	65	23
CFL	24	20	16
Special lamps	1	5	1

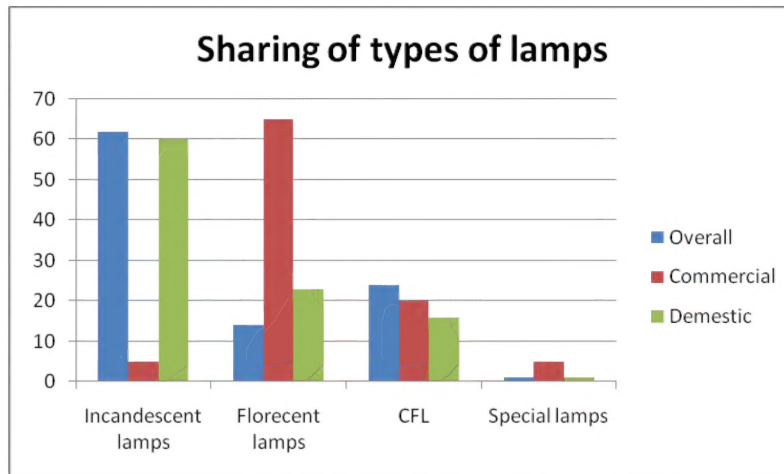


Figure 2: Showing Graphical of Table 2

Stock of CFL world production production growth in terms of percentage of use vis-a- vis Indian senario for CFL can be put forth as in table 3 and figure 3. The figure suggests that position of Indian secenario has improved and technology and purchase power has resulted in relatively extra growth.

Table 3

Year	World Production Growth in %	Indian Prod Grow the in %
2001-02	7	26
2002-03	30	6
203-04	31	27
2004-05	29	56
2005-06	37	49
2008-09	62	55

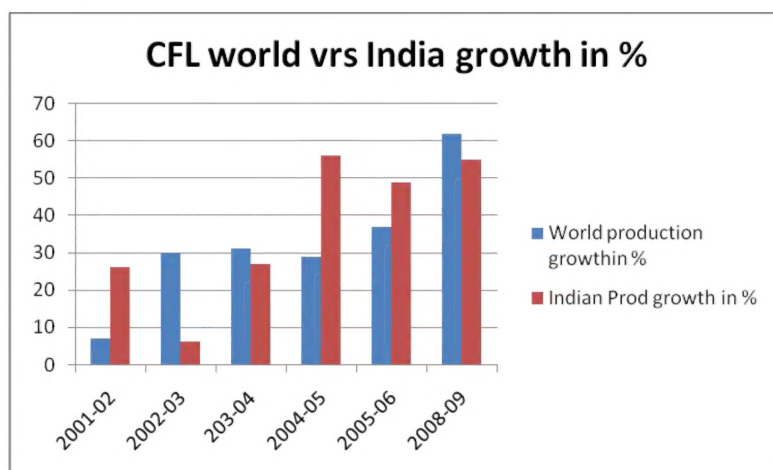
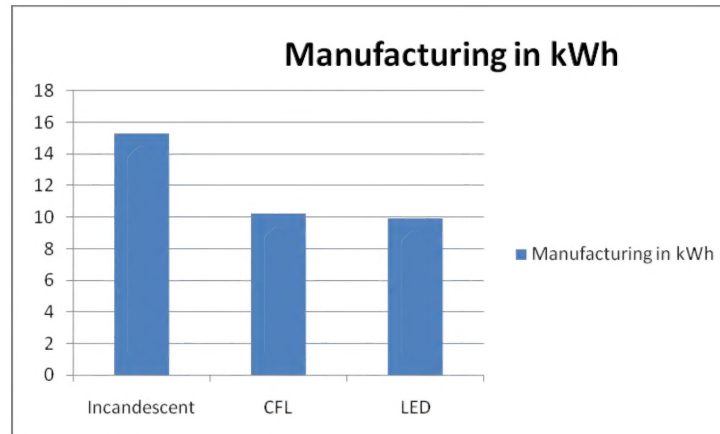
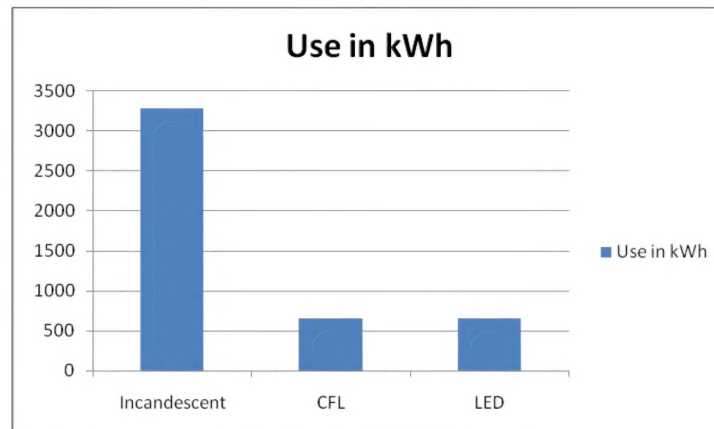


Figure 3

Power requirement i.e. principally requirement of power for manufacturing including the extraction of materials form used lamps for manufacturing the various types of lamps in normalized form i.e. considering 1 LED to 2.5 CFL and 1 LED to 25 incandescent lamps power requirement reported by [13] has been shown as per reports in table 4 and figure 4 and 5.

Table 4: Primary Energy Demand

Lamp Type	Required For Manufacturing & Extraction In kWh	Use in kWh
Incandescent	15.3	3290
CFL	10.2	658
LED	9.9	658

**Figure 4****Figure 5**

Principally the LED and CFL can save power to extent of 80 % and considering 1 watts gives 188 lumens light for white LED lamps [12,14] one can clearly visualise glism for possible power saving in event of replacement / use against incandescent lamps can be seen. In table 5 and figure 6 we can see the variation of efficacy of lighing devices and fixtures in all the basic case i.e. Incandescent , CFL and LED lamps.

Table 5: Table Showing Efficacy of Lighting Devices & Fixtures

Lamp Type	Ballast Eff %	Device Efficacy Lu/W	Fixture Eff %	System Efficacy Lu/W
Incandescent	100	11	65	9
CFL	80	67.5	65	39
LED	85	124	67.5	94

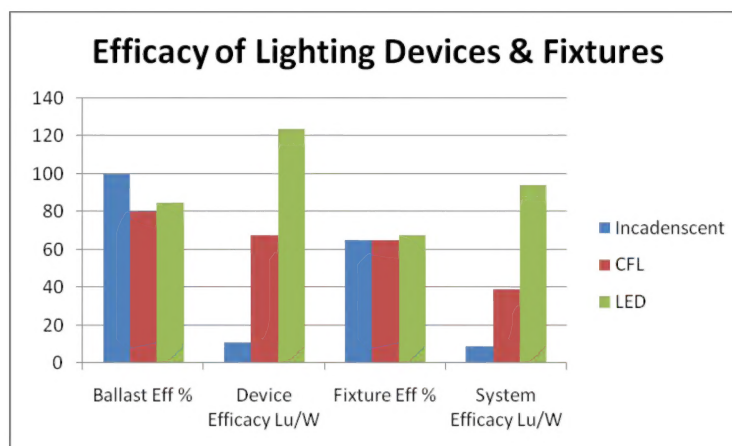


Figure 6

Consideration of output power of incandescent lamps to efficacy in lumens per watts to total available output in lumens can be seen as presented in the table 6 and its graphical representation as in figure 7.

Table 6: Table Showing Comparison of Efficacy to Power of Incandescent Lamps

Power in Watts	Efficacy (lu/Watts)	o/p in Lumens
5	5	25
15	7.33	110
25	8	200
40	12.5	500
60	14.17	850
100	17	1700
200	19.5	3900
300	20.67	6200

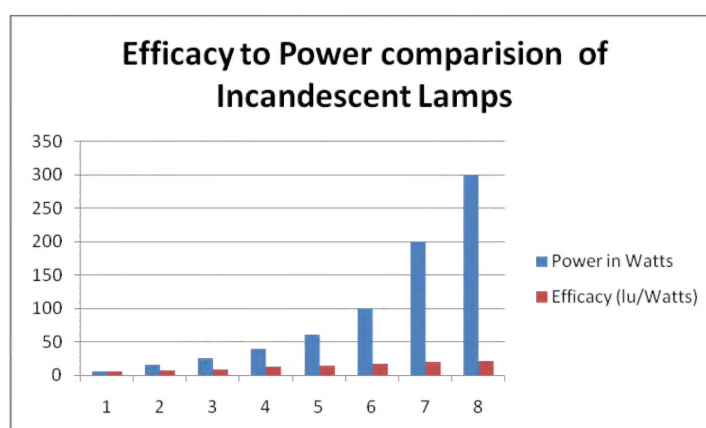


Figure 7

CONSTRUCTIONAL FEATURES, CONSTITUENTS & IMPACT ON ENVIRONMENT

The basic constructional & working details of the incandescent, CFL and LED lamps are well known to all. The important considerations here are the materials being used and after the end of life i.e. disposal stage when it is not recycled or extracted from the e waste and is dumped or left untreated gets mixed with soil and make the environment unsafe. In Indian scenario particularly in this sector we hardly come across the buyback options or extended producer responsibility (EPR) activities where the manufacturer or its agencies collect the wastes for proper technologically disposal

which includes recycling, reuse and extraction of materials which can be reused in order to save the virgin raw materials. Generally this type of e waste find settlement as stray throwing in barren land causing physical threats to living beings or land filling by the kabariwalas or local waste collectors or consumers. Importance of the wastes of lamps is the materials which are hazardous if allowed to mix in land or left open causing environmental degradation and the particles like broken glass pieces which can harm passers and create wounds.

Brief of Incandescent Lamps

In case of Incandescent lamps whose constructional detail is depicted in figure 8, the materials of concern are copper, tungsten, borosilicate consisting of boron and silica, lead oxide and manganese oxide in glass foam. The glimpse of materials flow & its use in particular sections can be seen in flow chart in figure 9.

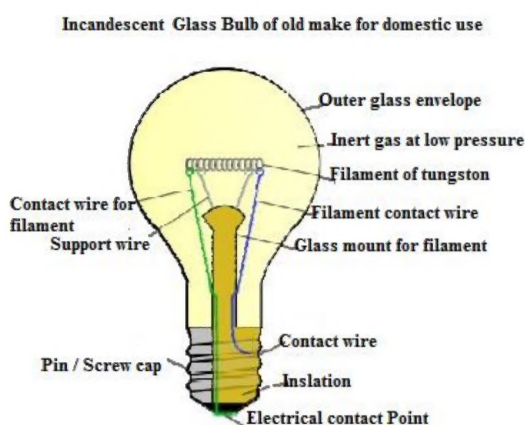
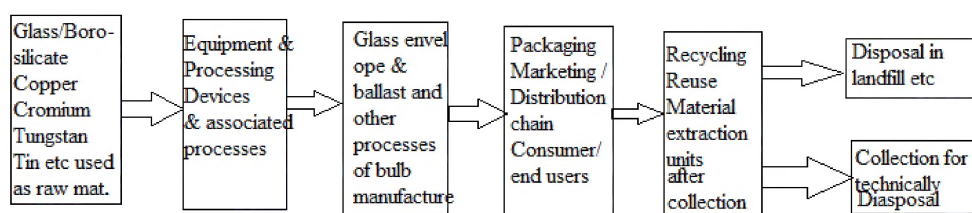


Figure 8



Material Flow for Incandescent Lamps and Life Cycle Flow Chart

Figure 9

Table 7

Unit/Material in Incandescent Lamps	Amount in Grams for Manufacturing and or Disposal by Landfill Etc	Part / Component of Incandescent Lamp	Material
Tin Plate base	2	Base	Tin
Tungsten filament	0.02	Filament	Tungsten for filament
Ballast glass insulation	2	Ballast, Lens and Stem	Borosilicate glass consisting Silica and Boron
Ballast internal filter	1	Ballast	Foam glass consisting lead oxide
Stem internal glass, wire	2	Ballast	Foam glass consisting Manganese oxide
Glass lens	20	Inert Gas	Argon, Neon, Nitrogen
Packaging card board	4	Contacts	Copper

Brief material presence / existence in incandescent lamp on unit basis in various sections can be seen in table 7.

Brief of Florescent Tube Lamps

The case of Florescent tube (FT) is no new but the compact florescent lamps (CFL) are relatively new entries with the replacement of old existing magnetic ballasts replaced by electronic ballasts. In general as a clear difference from the Incandescent lamps where electrical power conversion is limited to 3 % in CFL it ranges from 17 to 21 %. The population one expects from the study comes to around 33 to 45 % in Urban in contrast to rural replacement limited to less than 10 % inclusive of FT till date. It is worth mentioning that conversion ratio of CFL is around 60 to 72 Lumens to per Watts. In particular the old segment of these florescent tubes i.e. Fluorescent Tube Lights (FTLs) one must be clear that it is mainly available in version of 40-watt and 36 Watt (even 26 W) version. The fluorescent tube is capable of providing 2,150 lumens which is around five times the capacity of ordinary standard incandescent 40-watt bulb which is 455 lumens. Figure 10 Fluorescent Tube Light. Life of FLT is longer and heat generated is lesser. The latest FLT T-8 and T-5 having tri-band phosphor are more energy efficient. In general CFL mainly consists of two parts namely gas filled tube popularly known as burners or bulbs and Ballast which is now limited to Electron Ballast consisting of circuit board, DC to AC inverter.

The general constructional details and material flow from manufacturing to disposal activity for the FLT and CFL is represented in figure 10, 11 and 12.

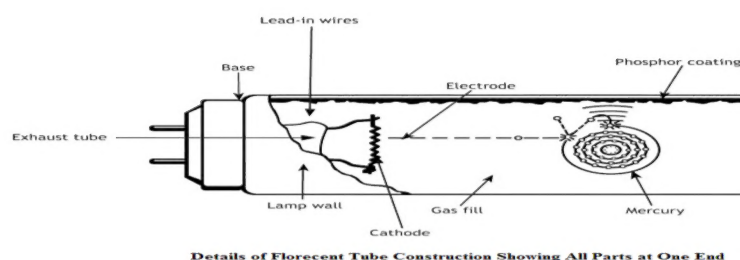


Figure 10



Figure 11

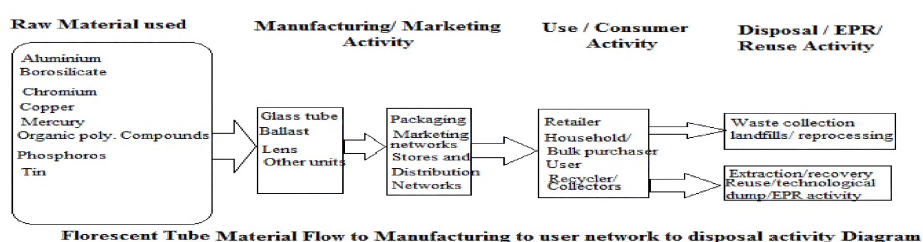


Figure 12

Details of materials and use in Florescent Lamp including CFL are as mentioned in the table 8. A typical unit of FL weight wise is mentioned in table in column 1 and 2. The typical materials used for lamps are mentioned in column 3 and 4 for analyzing it in context of hazardous affects on unplanned disposal to the individuals and environment.

Table 8

Unit/Material in Florescent Lamps	Amount in Grams for Manufacturing and or Disposal by Landfill Etc	Part / Component of Florescent Lamp	Material
PCB Aluminum	3	PCB	Aluminum
PCB Copper	4		Copper
PCB Polymer material	1		Polymer material
PCB Poly Propylene	4		Poly Propylene
Cast Iron	6		Cast Iron
Poly foam	6		PVC
PVC	17	Ballast	Poly foam
Lamp mercury	0.005	Lamp	Mercury
Lamp Copper	2		Copper
Lamp Chromium	2		Chromium
Lamp Tin	5		Tin
Lamp lack glass	5		Black glass
Lamp borosilicate	34		Borosilicate
Corrugated packaging mat & fibers	4		Inert gases etc
Other inert gases etc	6	Packaging	Corrugated packaging mat & fibers

Brief of LED Lamps

In case of light emitting diode lamp (LED) which mostly find use because of the higher efficiency, longer life span, lower maintenance, resilience & shock resistance, no sudden failure and options of colors without filters LED has some disadvantages also such as very high initial cost, voltage dependence, temperature dependence of light and prominently blue light hazards for eyes

LED mainly consists of three parts namely arrangement / package to house LED, Lamp including base, ballast and Bulb with arrangement to enable bulb to be retained on the fixtures

The arrangement / packaging consists of housing , Lens (Lens is made of Silica Polymer or epoxy resins), Sub mount of silicon , Heat sink consisting of PCB of copper or aluminum, Anode and Cathode leads, lead free solder and most importantly LED Chip which consists of crystals deposited on substrate, phosphorous for white light and metals forming contacts & reflectors.

The general constructional details of LED have been outlined in figure 13 [15].

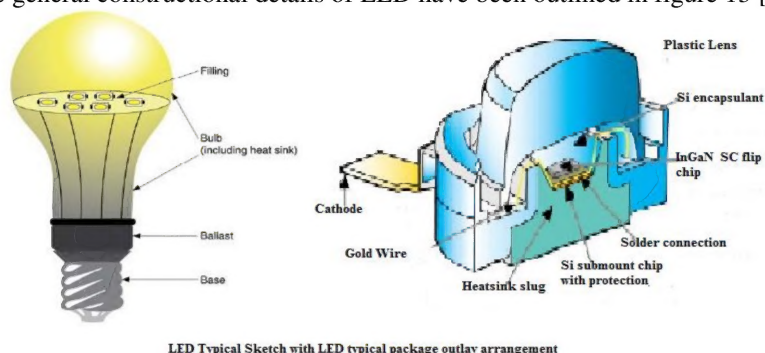


Figure 13

A typical flow activity from material flow to manufacturing, packaging and final disposal outline has been represented in figure 14 for typical light emitting diode lamps (LED).

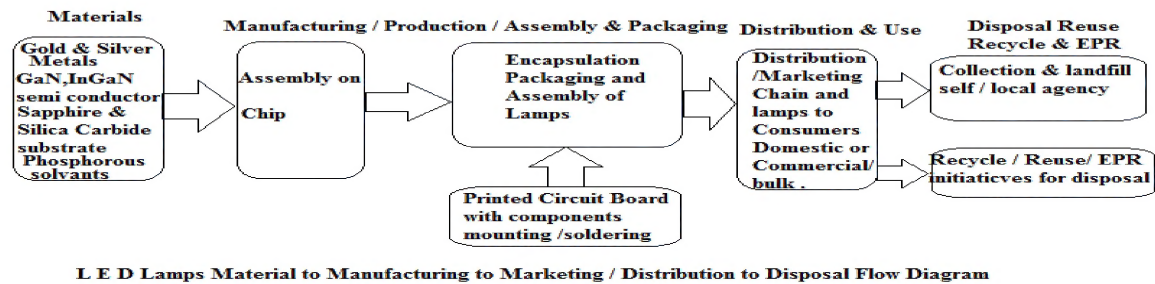


Figure 14

Inventory of LED material wise is as follows in table 9 for unit LED lamp.

Table 9

Lamp Part	Nature & Material	Weight in gm
Ballast	Foam , Polyurethane, rigid foam	3
	Cast iron and copper Inductor	10
	Semiconductor Transistor , capacitor , resistor diodes including zener ones	10.351
	PCB Aluminum and Copper mixed	100
	Copper wiring and solder	2
	Polypropylene housing	35
	Different ICs in housing & PET film	3
Lamp	Foam glass , tinplate steel base, Copper pins & base contacts, PVC base	25.7
	LED , borosilicate glass tube , Aluminum coating etc	43
Packaging	Corrugated board, mixed fiber, single wall and card	3

With briefs about all the lamps available two aspects always sound important for use of lamps and these are the life span and the energy utilization i.e. saving from the extensive uses. A comparison of life cycle can be noticed as per the following table as per reports mentioned in [3, 14].

Table 10

Lamp Type	Watts of Lamp	Lumen Produced	Life Time in Hrs	Efficacy	Weight	Energy Use in MJ?20mLu-hr)
Incandescent	60	900	1000	14.8	25	15600
Halogen / HIL	43	750	1000	21	350	13000
CFL	15	900	8500	57.1	96	3780
LED	12.5	800	25000	67.2	195	3540
LED adv	5.8	800	40000	102	180	1630

It is clear that LED and the most technologically coming LED is far more superior in terms of life time, energy consumption, efficacy etc.

METALS & THEIR HAZARDOUS EFFECTS ON HEALTH ON DISPOSAL

In the Incandescent , Florescent and Light Emitting Diode Lamps discussion so far we have come across Aluminum, Arsenic, Copper, Chromium, Gallium, Germanium, Manganese, Mercury, Lead, Silver, Tungsten and , Zinc.

The hazardous health effects specially on crude disposal needs to be put forth here. The details [7] are as follows in table 11.

Table 11

Metals	Hazardous Effects on Health Due to Metals Presence in Lamps Mixed in Wastes on Disposal	Metals	Hazardous Effects on Health Due to Metals Presence in Lamps Mixed in Wastes on Disposal
Aluminum	Intake / contact more than permissible limits can damage central nervous system Dementia / Loss of memory, listlessness or severe trembling Shaver's Disease (Pulmonary fibrosis and lung damage).	Lead	Higher exposure or intake can cause rise in blood pressure, kidney damage, Brain damage disruption of nervous systems, disruption of the biosynthesis of hemoglobin and anemia, diminished learning abilities of children, behavioral disruptions of children viz aggression, hyperactivity impulsive behavior etc.
Arsenic	Arsine is soluble in water and intake can cause irritation in the stomach and intestines, skin changes and lung irritation, cancer of skin, lungs, liver or lymphatic. infertility and miscarriages with women, skin disturbances, declined resistance to infections, heart disruptions and brain damage in both men and women. damage DNA and nerve injury.	Mercury	The exposure can cause sensory impairment, memory loss, weakness in muscle dermatitis, reduced fertility Impaired growth and development
Boron	High intake or exposure of boron can cause Effect on stomach, liver, kidneys & brain Impaired reproductive organs exposed to boron during pregnancy offspring may suffer from birth defects	Silver	High concentrations exposure may cause breathing difficulty, dizziness, headaches respiratory irritation, staggering, confusion & unconsciousness, brain, coma or even death. may damage liver, Kidney , may damage Eye, Lungs and result in cardiac abnormalities
Chromium	Contamination may cause Impaired heart conditions, disruptions of metabolisms and diabetes. nose irritations and nosebleeds. Skin rashes, ulcers stomachs upset, Respiratory problems, Weakening of immune systems, Kidney and liver damage , Alteration of genetic material even Lung cancer, etc.	Tin	Exposure can lead to Stomachache, Breathlessness, Eye and skin irritations, Sickness and dizziness , Severe sweating, Headaches, Urination problems, Liver damage, Malfunctioning of immune systems, Chromosomal damage, Shortage of red blood cells , Brain damage , Depressions
Copper	The excessive intake can cause Metal fever because of Copper contagion, Irritation of the nose, mouth and eyes, Headaches, stomachaches, dizziness, vomiting and diarrhea. Liver and kidney damage, , demyelization, renal disease, Copper deposition in the cornea Wilson's Disease, characterized by a hepatic cirrhosis Brain damage.	Silicon	Excessive Silicon intake or exposure can cause fibrosis in lung tissue, slight pulmonary lesions & respiratory hazard. irritation in skin and eyes on contact. irritation to lungs and mucus membrane. lung cancer, immunologic disorders and autoimmune diseases renal diseases and subclinical renal changes

Gallium	Acute exposure to Gallium (III) chloride can cause difficulty in breathing, chest pain, throat irritation, pulmonary edema partial paralysis.	Tungsten	Excessive exposure can cause <i>Irritation of skin and eyes on contact.</i> Inhalation in lungs and mucus membrane. Anorexia, colic, in coordination of movement, trembling, dyspnea and weight loss.
Germanium	Germanium in its different forms can cause skin redness & pain, eyes redness & Pain irritation to eyes, skin and respiratory tract abdominal cramps, burning sensation, cough.	Zinc	The extreme exposure can cause stomach cramps, skin irritations, anemia, vomiting/ nausea damage to pancreas, disturb the protein metabolism

PRESENT STUDY REGARDING LAMPS USE STATUS & DISPOSAL IN JHARKHAND

Jharkhand is a well diversified area having mix of urban and rural populations. The urban population is around 20 – 24 % in all the districts taken collectively. All the 24 districts were considered for study. 100 questionnaires every district divided equally in urban and rural areas with subdivision between domestic, commercial and offices in equal proportion were circulated and collected. On average units of 5 members in one unit or family was considered which results in index of representation as population divided by 5 divided by 2400 for state or 100 for district. As per normalized factor number of incandescent lamp, FL and LED lamps are calculated. Taking average life of incandescent lamp as 1 year 2.5 years for CFL and 10 years for LED one can get the trend of electronic waste assuming that the portion parted for sell and agency in the disposal methods adopted segment of data collection. On an average trends set by the various studies regarding reuse, recycle and retrieval of material can be further taken care of.

The data and information gathered by the survey has been tabulated in table 12 and table 13. Graphical presentations of the various factors for the individual districts have been put forth from figure 14 to 17.

Table 12: Population Considered as Per [16]

Districts of Jharkhand State	Population of District	Sample size	Details received from	Lamps in Use				Awareness of hazard / constituents	Disposal Methods adopted			EPR awareness
				Innd	HIL	CFL	LED		Throw	Sell	Agency	
Ranchi	3234238	100	84	356	32	178	19	47	56	6	5	12
Lohardaga	379777	100	68	208	8	89	6	14	62	4	1	9
Gumla	1049530	100	66	192	6	59	2	9	57	2	0	11
Simdega	635538	100	59	176	2	46	1	2	48	6	0	16
Palamu	2233726	100	71	201	18	39	6	8	63	4	0	9
Latehar	768573	100	48	156	3	32	1	3	43	3	1	12
Gharwa	1202130	100	61	233	7	46	4	13	47	4	0	9
Wes Singh Bhoom	1470077	100	57	207	3	61	6	17	53	4	0	11
Saraikela	1113836	100	85	312	23	59	13	29	65	18	4	12
East Singh Bhoom	2569894	100	81	311	18	56	11	26	56	18	4	18
Dumka	1348711	100	76	208	14	45	9	19	48	12	2	11
Jamtara	693426	100	52	203	9	32	4	12	45	6	1	14
Sahebganj	1280650	100	46	158	4	29	6	9	38	5	1	8
Pakur	1151036	100	58	164	3	22	7	8	50	6	1	7
Godda	1290056	100	47	183	3	21	8	11	38	6	2	11
Hazaribag	2069260	100	79	307	11	59	12	42	65	6	1	19
Chatra	1011305	100	47	149	5	45	9	11	41	6	0	7
Koderma	503947	100	56	169	9	45	12	14	48	6	2	11
Giridih	2478616	100	60	225	8	34	8	11	54	5	1	9
Dhanbad	3109042	100	87	369	38	89	19	39	72	9	4	24
Bokaro	2089934	100	88	336	29	84	11	38	74	8	3	31
Deoghar	1482847	100	68	267	11	59	5	21	54	6	1	19
Ramghar	1093406	100	64	185	15	71	8	31	54	8	1	17
Khunti	576616	100	47	142	4	34	4	16	43	4	0	9

Figure 15 shows the required i.e. sample size selection to response outcome. The best responses are from the industrial districts and the least are from the relatively low industrial and backward districts. The commercial applications are also in semi domestic nature in such districts.

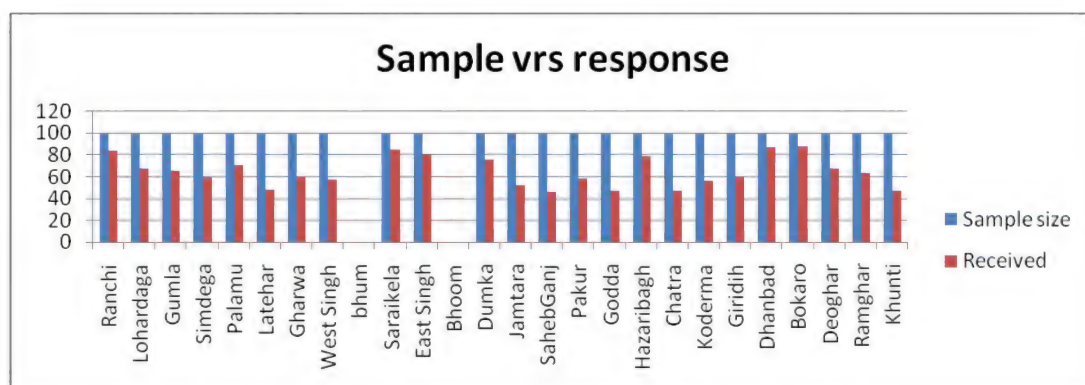


Figure 15

Figure 16 represents the stocks of different types of lamps. Conventional lamps mainly because of cost factor are most popular in use. Least number of LED despite of very long life and efficiency and efficacy find less use. Mostly these are in the commercial establishments only as tariff is also very in such cases. Public in general is very less know about the hazards and often handle these lamps in idea of physical damages only. The toxic and hazardous content knowhow is very limited. In general normal citizens are ignorant about other constituents in the lamps.

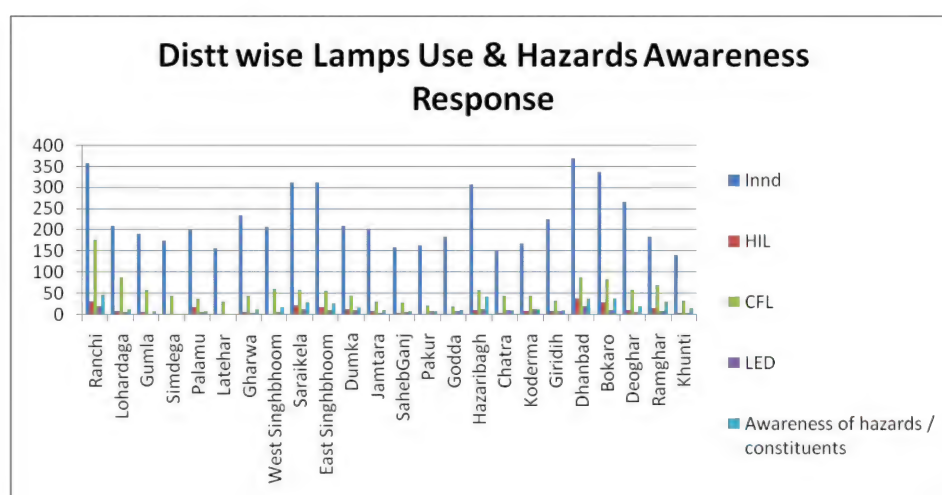


Figure 16

Next graphical representation figure 17 depicts about the tendency of general public about disposal. Official network for collection of such lamp wastes which may contain usable and reusable materials are wasted by throwing to get mixed with the soil for further contamination and making it more hazardous and dangerous for the inhabitants. State of Extended Producers Responsibility (EPR) is limited to warranty options of the CFL and LED and only these categories limited collection to the agencies or the manufacturer or representatives. After the warranty period even these CFL or LED lamps find the places in dustbins. A small section which is smart enough to get the worth of the wastes only go for handing over these wastes to kabariwalas who in turn shift these to small traders and from there to traders to recyclers or refurbishers for extraction of material from the wastes.

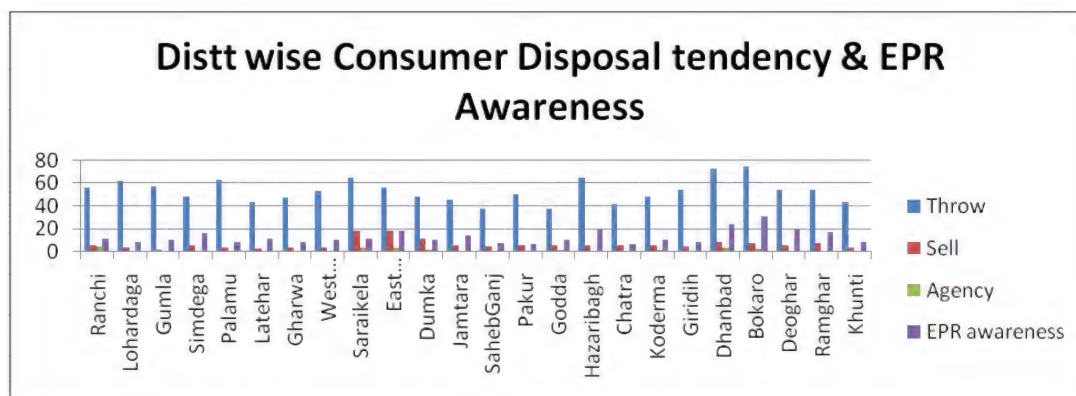


Figure 17

Table 13

Districts	If Govt. / Free Provided will Use CFL/ LED	Improved Light by CFL/ LED Use	Reduction in Elect Bill after CFL/ LED in %	Warranty/ Buyback Consideration for CFL/LED Use	CFL /LED Cost for Non Use	Ready to Even Pay for Hazard Reduction	Hardly Matters	Get CFL Repaired	Aware of Elect Saving	Interested to Know More
Ranchi	24	73	23	63	64	23	8	12	64	54
Lohardaga	38	65	21	55	58	25	5	11	48	38
Gumla	26	62	18	61	56	21	9	14	46	36
Simdega	29	57	15	52	49	12	11	1	39	39
Palamu	31	68	26	61	61	21	13	1	41	21
Latehar	18	39	26	29	38	19	10	2	28	38
Gharwa	31	56	21	50	41	20	6	4	41	31
West Singhb	37	53	22	43	47	13	8	2	37	37
Saraikela	35	81	24	51	65	11	9	11	25	35
East Singhb	31	76	21	56	61	16	4	5	21	31
Dumka	26	57	18	47	66	17	11	3	46	36
Jamtara	22	43	15	33	42	13	12	3	32	12
Sahebganj	26	36	25	26	36	16	10	3	36	26
Pakur	28	35	12	31	48	11	8	3	28	28
Godda	27	32	15	22	37	12	6	4	37	27
Hazaribag	29	68	17	48	69	18	9	12	39	29
Chatra	27	34	14	24	37	14	10	2	37	27
Koderma	26	45	19	25	46	15	11	8	36	26
Giridih	20	57	19	47	40	17	12	4	20	20
Dhanbad	37	65	21	45	67	15	11	12	47	27
Bokaro	28	78	24	38	68	18	10	11	28	28
Deoghar	28	45	23	35	58	15	9	8	38	28
Ramgha	24	46	19	36	44	16	9	10	34	64
Khunti	27	23	25	33	37	13	11	6	17	17

Details of variations of provision of lamps , importance of luminance resulting from various sources of lamps , due to replacement of lamps effective reduction in electric bills which may be seen as direct incentive has been dealt in figure 18. The to the user , effect of warranty or take back on investment and consideration of cost and other factors have been studied. The data collected suggest that general awareness about luminance prevails, bill reduction plays important role in changes but at same time the inaction among the consumers is prevelant which is reducing the pace of changes in eite group who rarely feels about cost at same time there is a sizable section for whom cost is a real factor for ot going towards this change.

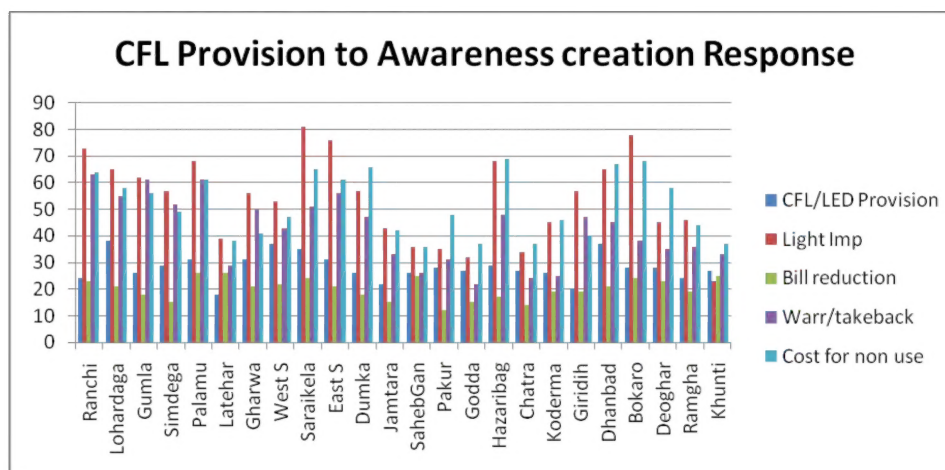


Figure 18

Graphical in figure 19 shows the trend and tendency of consumer or users for alerness for environment in terms of their rediness even to take the burden of cost for collection by the manufacturer of the local authorities. A good section which knows about possible option of repairing of CFL optes for it. Saving of power and in turn money is very well evident in almost all the districts. May be fr academic interest only population is willing to go for awareness. Even some ignorant population who are not bothered by such activities can also be seen, which may have either reason i.e. they have enough to pay so need not bother for house hold activities or who has no means for replacement.

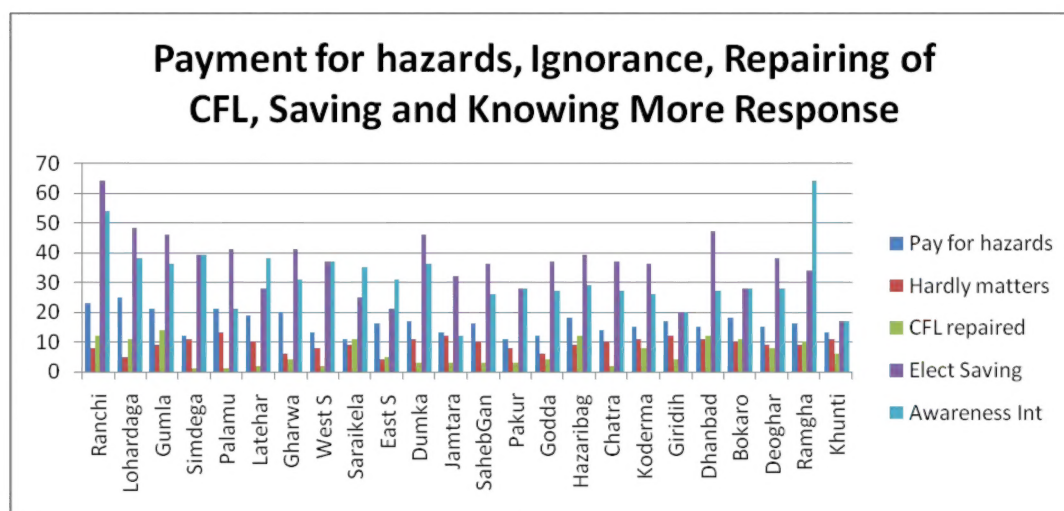


Figure 19

The study reveals that there is ample scope to energize population for saving of power by replacement of lamps for making provision for other useful works. The replacement of lamps will lead to a better less hazardous environment. The EPR and buy back options will facilitate the manufacturers for extraction and retrieval of input materials for reuse and meet requirements by recycling. Advancement in technology can further reduce hazardous inputs and ease human kind from its hazardous wastes and toxicity.

CONCLUSIONS

Worldwide lighting sources pay an important role in power consumption. On an average 18 to 20 % power is consumed by the lighting sources. Saving of power from this section can be achieved by making use of relatively new products like CFL, LED lamps etc. The CFL life span and efficiency is much larger to incandescent lamps which in turn

are over taken by LED lamps. The save amount of light what a incandescent lamp of 60 W can provide a CFL of 15 W and a LED lamp of 5.8 W can provide. Life span of lamps also drastically and gradually increases causing reduction in waste inventory. The electricity bill on this account can be drastically reduced.

Drawback of environment degradation due to mercury and other hazardous materials which find use in CFL and LED lamps has to be adjusted and minimization with improved technology has to be carried forward. The main concerns of the florescent lamps are the present mercury. The level of mercury has reduced from 15 mg to 5 mg in recent CFLs. The HIL are still major concerns as mercury levels are between 50 mg to 1000 mg in each unit depending on its wattage.

The end of life i.e. disposal of these have been neglected till date. Mechanism of manufacturer's involvement by EPR and buy back facilities has to be made available for safe and technological disposal of such hazardous / toxic substance containing lamps. At present nearly 90 % lamps find place in local dustbins as users throw these. 95 % population doesn't know the constituents of lamps. In case of collection in the present scenario it is collected by the door to door collectors who hand over to small traders, from here it moves to traders who send the wastes to refurbisher or recycler. The refurbisher repairs lamps and resend to traders for sale and reuse. Dismantlers / recyclers takeout the electronic components from the PCB as per status are resend for reuse or recovery. After maximum recovery left out wastes are technologically land filled or settled.

Electric power shortage is worldwide problem thus emphasis on reduction of consumption is need and smart move will be to increase lumen and reduce power consumption by shifting to more efficient and higher efficacy lamps. Reduction upto 80 % power requirement can be achieved. Lack of awareness and increased cost of CFL and very high cost of LED lamps needs a look from the governmental side. Provision of subsidy and financial incentives and phased replacement encouragement from law enforcing agencies can improve situation to large extent. Strict initiatives for replacement of all incandescent lamps with LED lamps in offices and public places will set a good example and this itself can cause power saving to larger tune.

Development of framework for safe disposal of e wastes for reduction in harardness and adherence to existing regulations and enactment of new needed acts i.e. regulations to fill gaps of the current ones should be taken up with utmost priority to do away the harardness and reduce the toxicity in environment.

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